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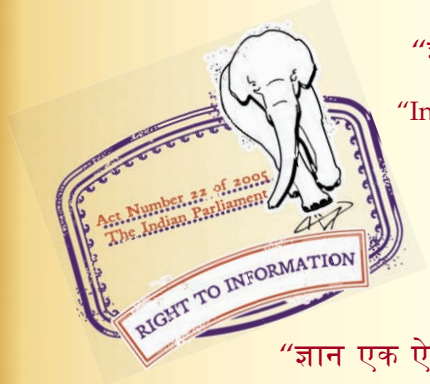

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Indian Standard

SPECIFICATION FOR SUMMATION CURRENT TRANSFORMERS

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MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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SPECIFICATION FOR SUMMATION CURRENT TRANSFORMERS

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SPECIFICATION FOR SUMMATION CURRENT TRANSFORMERS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 8 May 1973, after the draft finalized by the Instrument Transformers Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 In electrical supply practice, it frequently becomes necessary to obtain simultaneous victorial sum of currents in a number of feeders. To achieve this, summation current transformers are used. Use of summation current transformers also results in considerable saving in the first cost of the metering equipment and in its installation.

0.3 Summation current transformers are used in association with feeder current transformers which may or may not have the same ratios. Each feeder is provided with its own current transformer, ring-type or wound-primary type depending on the ratio and their secondary windings are connected to the appropriate primary winding of the summation current transformer. The summation current transformer has a single secondary winding which is connected to the burden. It is essential that summation current transformers are used on currents of same frequency and phase.

0.4 This standard contains clause **5.1.1** which calls for an agreement between the purchaser and the manufacturer.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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1. SCOPE

1.1 This standard covers requirements of summation current transformers for metering only for use with feeder current transformers which may or may not have the same transformation ratios.

1.2 This standard does not cover the main or feeder current transformers.

*Rules for rounding off numerical values (*revised*).

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions given in IS : 1885 (Part XXVIII)-1972* and the following shall apply.

2.1.1 *Summation Current Transformer* — A current transformer intended to summate the currents in a number of feeders in association with the feeder current transformers.

NOTE — A summation current transformer consists of two or more primary windings, electrically insulated from each other, wound on a common core and connected to the respective secondary windings of main current transformers of the circuits to be summated. It has a single secondary winding which feeds the connected burden a current proportional to the summated primary current.

2.1.2 *Summation Current Transformer Burden* — Impedance of the burden connected to the secondary of summation current transformer and expressed in ohms and power factor.

2.1.3 *Equal Primary Winding Summation Current Transformer* — A summation current transformer with primary windings having equal number of turns and equal rated currents.

2.1.4 *Unequal Primary Winding Summation Current Transformer* — A summation current transformer with primary windings having unequal number of turns but equal rated currents.

3. RATINGS

3.1 Rated Primary Current — The rated primary current of the summation current transformer shall be 1, 2 or 5 A.

3.2 Rated Secondary Current — The rated secondary current of the summation current transformer shall be 1 or 5 A.

3.3 Rated Output — The rated output of the summation current transformer shall be 5, 7·5, 10 and 15 VA.

4. ACCURACY CLASS

4.1 Standard Accuracy Classes — The accuracy classes shall be designated by the highest permissible percentage current error at rated primary currents for the accuracy class concerned. The standard accuracy classes for summation current transformers shall be 0·2, 0·5 and 1.

4.2 Limits of Current Error and Phase Displacement — The current error and the phase displacement at the rated frequency shall be in accordance with Table 1, when the secondary burden is any value from 50 percent to 100 percent of the rated burden (burden power factor —0·8).

*Electrotechnical vocabulary: Part XXVIII Instrument transformers.

TABLE 1 LIMITS OF ERRORS

(*Clause* 4.2)

Class	Percentage Current Error at Percentage of Rated Current				Phase Displacement in Minutes at Percentage of Rated Current			
	10	20	100	120	10	20	100	120
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
0·2	± 0·5	± 0·35	± 0·2	± 0·2	± 20	± 15	± 10	± 10
0·5	± 1·0	± 0·75	± 0·5	± 0·5	± 60	± 45	± 30	± 30
1·0	± 2·0	± 1·5	± 1·0	± 1·0	± 120	± 90	± 60	± 60

NOTE — The above accuracy limits are valid only for summation current transformers with feeder current transformers having same rated secondary currents and when all the primary circuits of the summation current transformers are carrying the same percentage current. This stipulation is conveniently fulfilled by connecting all primary windings in series during testing.

For certain applications it may be necessary to obtain the transformation errors within the prescribed limits when any of the individual primary windings alone is carrying the current; the other primary windings being left open-circuited. This calls for a special design of the summation current transformers and the purchaser shall so stipulate his requirement at the enquiry stage.

Method of testing, to be used when the accuracy of transformation is required between individual primary windings and the secondary winding, is given in Appendix A.

5. MARKING

5.1 Rating Plate — Every summation current transformer shall have the following particulars indelibly marked on it or on a label permanently secured to it or its casing:

a) A reference to this standard, that is, IS : 6949-1973;

b) Manufacturer's name and country of origin;

c) Manufacturer's serial number and/or type designation;

d) Rated transformation ratio (for example, 5+5+5/5);

e) Rated frequency;

f) Feeder current transformer ratios (winding 1 : 100/5, winding 2 : 100/5, winding 3 : 300/5); and

g) Rated output and accuracy class.

5.1.1 Class of insulation may also be marked by agreement between the purchaser and the manufacturer.

5.2 Terminal Markings — The terminal markings shall be in accordance with Appendix B.

5.3 The summation current transformers may also be marked with the Standard Mark.

5.4 The use of the Standard Mark is governed by the provisions of Bureau of Indian Standards Act, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

6. TESTS

6.1 Classification of Tests

6.1.1 *Type Tests* — The following shall comprise the type tests:

a) Verification of terminal markings and polarity (*see* **6.2**),
b) High voltage power frequency test on primary winding (*see* **6.3**),
c) High voltage power frequency test on secondary winding (*see* **6.4**),
d) Over voltage inter-turn test (*see* **6.5**),
e) Accuracy test (*see* **6.6**), and
f) Temperature-rise test (*see* **6.7**).

6.1.2 *Routine Tests* — The following shall comprise the routine tests and shall be carried out on all the current transformers:

a) Verification of terminal markings and polarity (*see* **6.2**),
b) High voltage power frequency test on primary winding (*see* **6.3**),
c) High voltage power frequency test on secondary winding (*see* **6.4**),
d) Over voltage inter-turn test (*see* **6.5**), and
e) Accuracy test (*see* **6.6**).

6.2 Verification of Terminal Markings and Polarity — Terminal markings and polarity shall be verified for their compliance with **5.2.**

6.3 High Voltage Power Frequency Test on Primary Winding — The test shall be conducted in accordance with IS : 2071-1962*. The test shall be applied between the terminals of the primary windings connected together and earth, the frame, case (if any), core (if intended to be earthed) and all terminals of the secondary winding being connected together and earthed. A test voltage of 2 kV(rms) shall be applied for one minute. There shall be no disruptive discharge.

*Methods of high voltage testing.

6.3.1 When the primary winding is divided into two or more sections, each section shall withstand for one minute a test voltage of 2 kV (rms) applied between the section and all other sections windings, frame and case (if any) connected together and earthed.

6.4 High Voltage Power Frequency Test on Secondary Winding — The test shall be conducted in accordance with IS : 2071-1962*. The test voltage shall be applied between the terminals of secondary winding connected together and earth, the frame, case (if any), core (if intended to be earthed) and all the terminals of the primary winding being connected together and earthed. A test voltage of 2 kV (rms) shall be applied for one minute. There shall be no disruptive discharge.

6.4.1 When there are more than one secondary winding or sections, each winding or section shall withstand the test voltage for one minute. A test voltage of 2kV (rms) shall be applied between the section and all other sections, windings, frame and case (if any) connected together and earthed.

6.5 Over Voltage Inter-Turn Test — This test is to be carried out in accordance with **6.5.1** or **6.5.2** for summation current transformer having equal primary winding and in accordance with **6.5.2** for summation current transformer having unequal primary windings.

6.5.1 With the secondary winding open-circuited, a voltage at rated frequency shall be applied to the primary winding connected in series. The value of voltage shall be such as to produce a primary current of rms value equal to the rated primary current or a value which corresponds to a secondary voltage of 3·5 kV peak whichever is lower. The applied voltage shall be withstood satisfactorily for one minute.

6.5.2 With the primary winding open-circuited, a voltage at rated frequency shall be applied to the secondary winding. The value of the voltage shall be such as to produce a secondary current of rms value equal to the rated secondary current or a value of 3·5 kV peak whichever is lower. The applied voltage shall be withstood satisfactorily for one minute.

NOTE — The overvoltage inter-turn test is not intended to reproduce service condition with the secondary winding open-circuited, but only to indicate that the inter-turn insulation is sound, and for this reason the wave-shapes of the voltage and current are not specified. Open-circuiting of a secondary winding/circuit under service conditions (particularly, if the secondary winding has a large number of turns) may produce excessive heating and permanent magnetization in the core and dangerous dielectric stress on the insulation, which may permanently damage the current transformer. The condition is, therefore, to be avoided.

*Methods of high voltage testing.

6.6 Accuracy Test — The summation current transformer shall be tested for compliance with **4.2**. The secondary burden used for the test shall have power factor of 0·8 lagging except when the burden is less than 5 VA, in which case the power factor of 1·0 shall be used. In no case shall the test burden be less than 1 VA. The test shall be made at each value of the current given in Table 2 at 50 percent and 100 percent of the rated burden.

6.6.1 In case it is not possible to feed all the primary windings of the summation current transformer with appropriate value of current from different feeders, it shall be permissible for the purpose of this test to connect all the primary windings in series and pass maximum rated primary current through them.

6.6.2 The routine accuracy test shall be made in the same way as in **6.6** and **6.6.1** but at the percentage of rated currents shown in Table 2.

TABLE 2 TEST CURRENTS

(*Clauses* 6.6 *and* 6.6.2)

Class	Percentage of Rated Current
0·1 and 0·2	120, 100, 20 and 10
0·5 and 1·0	120 and 20

6.7 Temperature-Rise Test — This test comprises the measurement of:

a) dc resistance of the windings, and

b) temperature-rise.

6.7.1 *Measurement of dc Resistance* — To account for the loss in the summation current transformer primary and secondary windings, the dc resistances of both these windings are to be measured at room temperature and converted to the values at 75°C as follows:

$$R_2 = R_1 \frac{(t_2 + 234{\cdot}5)}{(t_1 + 234{\cdot}5)}$$

where

R_2 = resistance in ohms at t_2°C,

R_1 = resistance in ohms at t_1°C,

t_2 = final temperature (75°C), and

t_1 = the initial temperature (room temperature in °C).

6.7.2 The temperature-rise of the summation current transformer winding when carrying the primary current equal to the rated continuous thermal current at a rated frequency and with rated burden shall not exceed

the appropriate values given in Table 3. The temperature-rise of the winding is limited by the lowest class of insulation either of the winding itself or of the surrounding medium in which it is embedded.

TABLE 3 LIMITS OF TEMPERATURE-RISE

(*Clauses* 6.7.2 *and* 6.7.4)

Sl No.	Class of Insulation	Maximum Temperature Rise °C
(1)	(2)	(3)
i)	All classes immersed in oil	55
ii)	All classes immersed in bituminous compound	45
iii)	Class not immersed in oil or bituminous compound:	
	Y	40
	A	55
	E	70
	B	80
	F	105
	H	130

Note 1 — If the ambient temperature is in excess of the value given in Appendix C, the permissible temperature-rise in this table shall be reduced by an amount equal to the excess ambient temperature.

Note 2 — If a summation current transformer is specified for service at altitude exceeding 1 000 m, and tested at an altitude below 1 000 m, the limits of temperature-rise given in this table shall be reduced by the following amounts for each 100 m excess over 1 000 m operating altitude:

a) Oil immersed transformers = 0·4 percent

b) Dry-type transformers = 0·5 percent

Note 3 — The reference ambient temperature for the purpose of temperature-rise measurement shall be 40°C.

6.7.3 For testing the summation current transformer in compliance with **6.7.2**, the transformer shall be mounted in the manner representative of the mounting in services. It shall be deemed to have attained a steady temperature when the rate of rise of temperature does not exceed 1°C per hour. The ambient temperature shall not exceed 40°C. The temperature-rise of the winding shall, where practicable, be measured by the change in resistance. But for the windings of very low resistance, thermocouples may be employed. The temperature rise of parts, other than windings, shall be measured by thermometers or thermocouples.

6.7.4 The temperature-rise measured on the external surface of the core and other metallic parts in contact with or adjacent to the insulation shall not exceed the appropriate value permitted for the adjacent parts of the winding as given in Table 3.

6.7.5 The temperature-rise of exposed current carrying parts including terminals connected to external conductors by screws and bolts shall not exceed the following limits:

Parts in air or oil:	40°C for joints untreated or treated with petroleum jelly or similar material, and 60°C for joints treated by soldering or silver plating.

APPENDIX A

(Note of Table 1)

METHOD OF TESTING

A-0. GENERAL

A-0.1 It is assumed here that the accuracy of transformation will be evaluated by comparing the transformer under test with a standard current transformer, the transformation errors of the standard current transformer being known.

A-1. PROCEDURE

A-1.1 Calculate a factor F which is defined as:

$$F = \frac{\text{Sum of the rated primary currents of feeder current transformers}}{\text{Rated primary current of the feeder current transformer (}\textit{under consideration}\text{)}}$$

Select a standard current transformer of ratio equal to:

$$\frac{F \times \text{Rated secondary current of summation current transformer}}{\text{Rated secondary current of summation current transformer}}$$

Determine the errors of transformation by comparing the transformation of current of the relevant primary winding of the summation current transformer with that of the standard current transformer. The errors should be measured at certain percentages of the rated primary current of the standard current transformer which are derived in the following manner:

$$\text{Required percentage} = \frac{\text{Specified percentage}}{F}$$

Example:

Consider a summation current transformer of ratio 5+5+5/5 and class 0·5 accuracy. Windings 1 and 2 are for feeder current transformer of ratio 800/5 A and winding 3 is for feeder current transformer of ratio 400/5 A. It is required to test the accuracy of transformation of individual primary windings and the secondary winding of the summation current transformer.

First consider the primary windings 1 and 2 suitable for feeder current transformers of ratio 800/5 A:

$$F = \frac{800 + 800 + 400}{800} = \frac{2\,000}{800} = \frac{5}{2}$$

$$\text{Standard current transformer ratio} = \frac{5}{2} \times \frac{5}{5} = \frac{12{\cdot}5}{5}$$

Rated primary current of standard current transformer is 12·5 A and its rated secondary current is 5 A.

Compare the summation current transformer primary winding 1 with the standard current transformer at the following percentage currents. The limits of permissible errors are also indicated for class 0·5 accuracy:

Percentage Current	*Current Error*	*Phase Displacement in Minutes*
$\frac{120}{F} = 48$	±0·5	±30
$\frac{100}{F} = 40$	±0·5	±30
$\frac{20}{F} = 8$	±0·75	±45
$\frac{10}{F} = 4$	±1·0	±60

APPENDIX B

(Clause 5.2)

TERMINAL MARKINGS

B-1. DETAILS

B-1.1 The terminal markings shall identify:

a) the primary and secondary windings;

b) the relative polarities of windings and winding sections; and

c) the intermediate tappings, if any.

B-2. METHOD OF MARKINGS

B-2.1 The terminals shall be marked clearly and indelibly either on their surface or in their immediate vicinity.

B-2.2 The markings shall consist of letters followed or preceded, where necessary, by numbers. The letters shall be block capitals.

B-2.3 The markings of summation current transformers shall be as indicated in Fig. 1.

B-2.4 All the terminals marked $1P_1$, $2P_1$, $3P_1$ and S_1 shall have the same polarity at any instant.

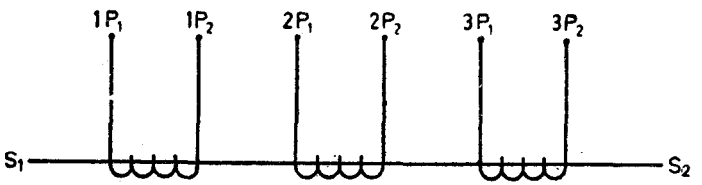

FIG. 1 TERMINAL MARKINGS FOR SUMMATION CURRENT TRANSFORMER WITH THREE PRIMARY WINDINGS

APPENDIX C

(*Note* 1 *of Table* 3)

SERVICE CONDITIONS

C-1. Unless otherwise stated, the summation current transformers shall be suitable for use under the following service conditions:

a) Maximum ambient air temperature = 45°C

b) Maximum daily average ambient air temperature = 35°C

c) Maximum yearly average ambient air temperature = 30°C

d) Altitude up to 1 000 m

e) Atmospheres which are not heavily polluted

f) Atmospheric climate conductive to growth of fungi and condensation of moisture

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